

Name KEY Rec. Instr. \_\_\_\_\_

Two-Digit Section No. \_\_\_\_\_ Lab. Instr. \_\_\_\_\_

1. [7 points] The work done when a gas is expanded in a cylinder is  $-199$  J. A heat transfer of  $170$  J occurs from the surrounding to the gas. Calculate  $\Delta U$  of the gas in Joules.

$$w = -199 \text{ J}$$

$$q = +170 \text{ J}$$

$$\Delta U = q + w = 170 - 199 = -29 \text{ Joules}$$

2. [7 points] A system receives  $50$  J of electrical energy and delivers  $150$  J of pressure-volume work against the surroundings while gaining  $300$  J of heat energy. What is the change in the internal energy of the system?

$$\Delta U = \underbrace{+50 \text{ J}}_{\text{electrical work}} - \underbrace{150 \text{ J}}_{\text{P}\Delta V \text{ work}} + \underbrace{300 \text{ J}}_{\text{heat}} = 200 \text{ Joules}$$

3. [7 points] A system undergoes a process in which  $\Delta U = -300$  J while gaining  $100$  J of heat energy and undergoing an expansion against  $1.0$  atm. What is the change in the volume (L)?

$$\Delta U = q - p\Delta V = -300 \text{ J} = +100 - p\Delta V$$

$$p\Delta V = 400 \text{ J} \times \left( \frac{1 \text{ L-atm}}{101.325 \text{ J}} \right) = 3.9477 \text{ L-atm}$$

$$\Delta V = (3.9477 \text{ L-atm}) / (1.0 \text{ atm}) = \underline{\underline{3.9 \text{ Liters}}}$$

4. [9 points] When  $375$  J of heat is added to  $35.0$  g of benzene,  $\text{C}_6\text{H}_6$ , the temperature increases by  $6.18^\circ\text{C}$ . Calculate the molar heat capacity of benzene ( $\text{J}/\text{mole}\cdot^\circ\text{C}$ ). (Atomic weights: C =  $12.01$  g/mole, H =  $1.008$  g/mole).

$$q = n C_p \Delta T$$

$$C_p = \frac{q}{n \Delta T} = \frac{375 \text{ J}}{\underbrace{35.0 \text{ g}}_q \underbrace{\left| \frac{78.108 \text{ g}}{\text{mole C}_6\text{H}_6} \right|}_{1/n} \underbrace{6.18^\circ\text{C}}_{\Delta T}}$$

$$C_p = 135 \text{ J}/\text{mole}\cdot^\circ\text{C}$$

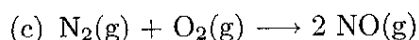
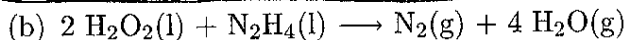
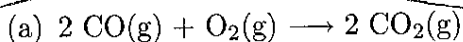
Name \_\_\_\_\_ **KEY** \_\_\_\_\_ Rec. Instr. \_\_\_\_\_

Two-Digit Section No. \_\_\_\_\_ Lab. Instr. \_\_\_\_\_

1. [7 points] A system generates 50 J of electrical energy and delivers 150 J of pressure-volume work against the surroundings while releasing 300 J of heat energy. What is the change in the internal energy of the system?

$$\Delta U = \underbrace{-50 \text{ J}}_{\text{electrical work}} - \underbrace{150 \text{ J}}_{\text{p}\Delta V \text{ work}} - \underbrace{300 \text{ J}}_{\text{heat}} = -500 \text{ J}$$

2. [7 points] Determine which of the following reactions at constant pressure represent systems in which work is done on the system by the surrounding environment.



3. [7 points] A system undergoes a process in which  $\Delta U = -300 \text{ J}$  while releasing 100 J of heat energy and undergoing an expansion against 0.5 atm. What is the change in the volume (L)?

$$\Delta U = q - p\Delta V = -300 \text{ J} = -100 - p\Delta V$$

$$p\Delta V = 200 \text{ J} \times \left( \frac{1 \text{ L}\cdot\text{atm}}{101.325 \text{ J}} \right) = 1.97385 \text{ L}\cdot\text{atm}$$

$$\Delta V = (1.97385 \text{ L}\cdot\text{atm}) / (0.5 \text{ atm}) = 3.9 \text{ liters}$$

4. [9 points] How much heat energy (kJ) must be supplied to heat 200.0 g of linseed oil from 20.0°C to 50.0°C in a copper vessel weighing 500.0 g. The specific heat of linseed oil and copper are 1.84 J/g°C and 0.38 J/g°C respectively.

$$q = m_{\text{Cu}} C_s^{\text{Cu}} \Delta T + m_{\text{oil}} C_s^{\text{oil}} \Delta T$$

$$q = (500.0 \text{ g})(0.38 \text{ J/g}\cdot^\circ\text{C})(30.0^\circ\text{C})$$

$$+ (200.0 \text{ g})(1.84 \text{ J/g}\cdot^\circ\text{C})(30.0^\circ\text{C})$$

$$q = 5,700 \text{ J} + 11,040 \text{ J} = 16,740 \text{ J}$$

$$q = 1.67 \times 10^4 \text{ J}$$

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1. [7 points] A system receives 50 J of electrical energy and delivers 150 J of pressure-volume work against the surroundings while releasing 300 J of heat energy. What is the change in the internal energy of the system?

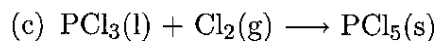
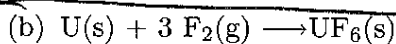
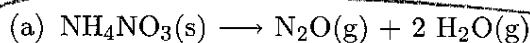
$$\Delta U = \underbrace{+50 \text{ J}}_{\text{electrical work}} - \underbrace{150 \text{ J}}_{\text{P}\Delta V \text{ work}} - \underbrace{300 \text{ J}}_{\text{heat}} = -400 \text{ J}$$

2. [7 points] The work done when a gas is compressed in a cylinder is 199 J. A heat transfer of 270 J occurs from the gas to the surroundings. Calculate  $\Delta U$  of the gas in J.

$$\Delta U = q + w = q - P\Delta V = -270 \text{ J} + 199 \text{ J}$$

$$\boxed{\Delta U = -71 \text{ J}}$$

3. [6 points] Determine which of the following reactions at constant pressure represent systems that do work on the surrounding environment.



4. [10 points] A sheet of 10.0 g of gold at 18.0°C is placed on a 20.0 g sheet of iron at 55.5°C. What is the final temperature of the two metals assuming that no heat is lost to the surroundings. The specific heats of gold and iron are 0.129 J/g-°C and 0.444 J/g-°C respectively.

$$q_{\text{Au}} + q_{\text{Fe}} = M_{\text{Au}} C_s^{\text{Au}} \Delta T_{\text{Au}} + M_{\text{Fe}} C_s^{\text{Fe}} \Delta T_{\text{Fe}} = 0$$

$$(M_{\text{Au}} C_s^{\text{Au}} + M_{\text{Fe}} C_s^{\text{Fe}}) T_f = M_{\text{Au}} C_s^{\text{Au}} T_i^{\text{Au}} + M_{\text{Fe}} C_s^{\text{Fe}} T_i^{\text{Fe}}$$

$$T_f = \frac{M_{\text{Au}} C_s^{\text{Au}} T_i^{\text{Au}} + M_{\text{Fe}} C_s^{\text{Fe}} T_i^{\text{Fe}}}{M_{\text{Au}} C_s^{\text{Au}} + M_{\text{Fe}} C_s^{\text{Fe}}}$$

$$T_f = \frac{(10.0 \text{ g})(0.129 \text{ J/g}\cdot^\circ\text{C})(18.0^\circ\text{C}) + (20.0 \text{ g})(0.444 \text{ J/g}\cdot^\circ\text{C})(55.5^\circ\text{C})}{(10.0 \text{ g})(0.129 \text{ J/g}\cdot^\circ\text{C}) + (20.0 \text{ g})(0.444 \text{ J/g}\cdot^\circ\text{C})}$$

$$T_f = 516.06 \text{ J} / 10.17 \text{ J/}^\circ\text{C} = 50.7434^\circ\text{C} \approx \boxed{50.7^\circ\text{C}}$$